Your Great Lake!

How much water does each Great Lake hold? Use this lesson as a demonstration or a classroom lesson to create visual representations of the Great Lakes, Lake Baikal, and the relationships between surface area, retention time and pollution effects.

BACKGROUND

The Great Lakes contain about 20% of the world's surface freshwater. How do the Great Lakes fit into the "big picture" of water worldwide? It turns out that surface freshwater is very rare--only 0.018% of all the freshwater in the world.

The Great Lakes are used by a large number of species for many different purposes. Humans drink this water, water fowl nest along the shores and a variety of fish find food within the waves. With so little of the world's water on the surface it is important to understand the factors that affect this valuable resource.

The Great Lakes display unique physical characteristics. Features such as surface area, depth, shape and location contribute to their distinctive attributes. One such attribute is retention time. The retention time of the lake is the amount of time it takes for enough "new" water to replace all the lake's current water. It can also be called renewal time, or the flush rate. It is a useful concept because it gives you an idea of how often the lake water is refreshed. The amount of time varies significantly among the Great Lakes--from 2.6 years for Lake Erie, to 191 years for Lake Superior.

Many toxic substances enter the Great Lakes via the atmosphere, carried with dust and precipitation. Toxins such as PCBs, dieldrin, toxaphene, mercury and DDT are threatening due to their ability to remain in the waters and sediment for a long period of time. These toxins are also a threat as they bio-accumulate in animal species such as fish. The repercussions of pollutant build up over time extend beyond the physical boundaries of the lake.

PROCEDURE

PART A: HOW MUCH WATER IS IN YOUR GREAT LAKE?

1. The salt(water) of the Earth

Fill a pitcher of water, and leave one empty. The full one represents all the water in the world! Brainstorm with the group where this water can be

This lesson was adapted from the Lake Superior Center's curriculum guide *Lake Effects*: "A Great Lake Superior" and "All the water in the world"

TOPIC
Lake Superior's size and volume in relationship to pollution susceptibility.

AUDIENCE
Grades 3-8; 5-30 students

LENGTH
30-40 minutes

GOAL
To understand that the enormous volume of water in each Great Lake is a small fraction of the Earth's total water.

OBJECTIVES

- *Students will be able to identify available fresh water as only a fraction of the world's water supply*
- *Students will be able to describe the depth of their Great Lake as very small when compared to the size of the surface area*
- *Students will understand how the enormous surface area of the Great Lakes makes them susceptible to airborne pollutants*
- *Students will understand that the amount of time for enough "new" water to replace all the lake's current water is called retention time. Retention time for the Great Lakes ranges from 2.6 years (Lake Erie) to almost 200 years (Lake Superior)*

MATERIALS

- *2 clear pitchers*
- *overhead made from Great Lakes maps*
- *1 broad and shallow clear plastic tub*
- *1 deep and narrow clear plastic tub*
- *1/2 cup flour*
- *1 sifter*
- *1 empty aquarium or another large clear container*
- *2 x 500 milliliter beakers or mayo jars*
- *red food coloring*

found. (Lakes, rivers, oceans, clouds, plants, animals etc.) Ask one student to pour the amount of the world's water that is salty (oceans) into the empty pitcher. Ask the group to tell the pourer when to stop--i.e. when they think the amount of world ocean water has been poured. Compare the amount that the group of students believes is salty, with the actual 97% (i.e. almost all of the pitcher water).

2. Chosen frozen

Consolidate the water and ask the group to think of it as all the FRESH water in the world (i.e. water found in lakes, rivers, clouds, groundwater, etc.). Ask a new pourer to pour all of the frozen freshwater out of the full pitcher. Again, ask for audience encouragement. The correct answer is about 97%. Ask the students where all of this ice is--the poles, glaciers, etc.

3. Groundwater

Consolidate the water again. This time the water will represent all of the FRESH LIQUID WATER in the world. Ask a new pourer to pour out all of the underground water out of the pitcher. Sources vary, but you will need to pour out 75-90% of the pitcher water! The tiny amount that is left: LIQUID, SURFACE, FRESHWATER is one of the most important commodities in the world--and the Great Lakes are just one-fifth (20%) of the remaining water!

PART B: HOW BIG IS YOUR GREAT LAKE?

1. Surface area

Show the overhead that illustrates your Great Lake surface area. See chart below for appropriate comparisons of size to other known geographic regions. If we could drive down the length of the lake in a car at 60 mph (96 km/hr), how long would that take?

Great Lake	Surface Area	As big as...	Breadth	Length	Travel time at 60 mph (96 km/h)
Lake Superior	31,700 sq. mi. (81,103 sq. km)	Maine	160 mi (257 km)	350 mi (563 km)	5 hours 50 minutes
Lake Michigan	22,300 sq. mi (81,103 sq. km)	NH, MA, RI, CT together	118 mi (190 km)	307 mi (494 km)	5 hours 7 minutes
Lake Erie	9910 sq. mi (25,700 sq. km)	Maryland	57 mi (92 km)	241 mi (388 km)	4 hours 1 minute
Lake Huron	23,000 sq. mi (59,600 sq. km)	VT, MA, RI, CT together	183 mi (245 km)	206 mi (332 km)	3 hours, 26 minutes
Lake Ontario	7340 sq. mi (18,960 sq. km)	New Jersey	53 mi (85 km)	193 mi (311 km)	3 hours 13 minutes

2. Depth

Ask the students to imagine shrinking their Great Lake down to a scale that would fit into the classroom. If your Great Lake was only 20' long, how deep would it be? Ask the students to estimate using their hands held horizontally. The answers are shown in the table below.

Great Lake	Average Depth	Lake depth if length = 20 ft
Lake Superior	483 ft (147 m)	1.5 mm
Lake Michigan	279 ft (85 m)	1.0 mm
Lake Huron	195 ft (59 m)	1.2 mm
Lake Ontario	283 ft (86 m)	1.8 mm

The Great Lakes are remarkably shallow for their surface area. If Lake Baikal, the deepest lake in the world, had a length of 20 feet, its average depth would be 6 mm. The Great Lakes are just a thin film of water on the Earth's crust.

3. Surface area and pollution

Invite two students to hold the two tubs--one narrow and deep, and one shallow and broad. The narrow tub represents Lake Baikal in Russia, which is the largest lake by volume in the world. The shallow one represents your Great Lake. The flour represents airborne pollution. Before the students sift flour on both pans at an equal rate, ask them to make a hypothesis about which "lake" will receive more "pollution." The students should see that there is more flour (total) on their Great Lake because of its broad surface area. As the students why surface area is important in regards to airborne pollutants--big surface areas can make large lakes like the Great Lakes susceptible to airborne pollutants.

PART C: RETENTION TIME- IS DILUTION A POLLUTION SOLUTION?

1. Pollutants

Fill one of the beakers or jars with tap water and stir in a few drops of food color so that it is bright red. Explain to the students that the red food color is to represent a pollutant that is in a nearby lake. It is nice to think that rainwater could eventually dilute the pollutant so that the lake would be clean again. Ask students how long they think this might take.

2. Clean water renewal

Try one complete renewal of water. To do this, fill the second beaker with tap water; this will represent the amount of rain and other new water that would completely replace the existing lake water. Have a student hold the "polluted" beaker. The waters will mix and overflow into the aquarium/bucket, and it will be evident that much of the "pollution" is gone from the lake. Ask the students if all of the "pollution" is gone from the lake? If you can still see the red, you have demonstrated that more than one retention time is needed to flush pollutants from the imaginary lake. It will typically take 3-4 replacements before you can no longer see the "pollutant." After the additional water replacements ask the students if they feel sure that the "pollutant" is completely gone from the "lake." Actually our eyes are rather unreliable at detecting pollution--small amounts of pollutants tend to be invisible to us.

3. Retention Time

Introduce the concept of retention tiem, and that it varies from lake to lake, with small lakes "flushing" more quickly than large lakes. Typical retention times for medium-size lakes in the Midwest are on the order of 3-10 years. Large lakes, such as Lake Superior, take much longer. Calculate the number of generations that it would take for your Great Lake to renew twice [(retention time) x 2 ÷ 25].

Great Lake	Retention Time (years)	Generations it takes to renew
Lake Superior	191	≈ 16
Lake Michigan	99	≈ 8
Lake Erie	2.6	< 1
Lake Huron	22	≈ 2

4. "Away"

Be sure to go back and examine the water that overflowed from the "polluted" lake. Did the pollutant go away? Discuss what "away" means. It is a key problem in pollution control that we often move pollutants around, rather than solve the problem. Another aspect of the dilution "solution" is to consider the source of the renewal water. If this water is polluted, the lake may never be clean again!

ASSESSMENT

For both student retention and assessment reasons, ask students to write a paragraph addressing the following topics: Your Great Lake's surface area, depth, retention time, susceptibility to pollutants, etc.

EXTENSIONS

1. Have students explore the local newspaper for mention of pollution or clean-up efforts. What are some

sources of pollution that may affect the health of the lake? What are people doing to prevent these types of pollution?

2. Brainstorm a list of how we can take care of our limited freshwater:

- Reduce consumption of fossil fuels, to keep down the air pollution that might end up as toxic or acid rain falling into the lake.
- Be careful with potentially hazardous household products such as drain cleaner, paint thinner, and pesticides, if you use them at all; improper use or disposal could contaminate the lake.

3. Have students estimate or measure the amount of water they use and for what purposes each day. Compare the amount you use to the total volume of your Great Lake. Multiply the amount you use by 10 to represent 10 people using the same amount of water. How about 1000 people? 1,000,000 people? How do these amounts compare?